

5 • Reactions In Aqueous Solution

PRACTICE TEST

- On the basis of the solubility rules, which of the following is insoluble?
 - K_2O
 - Na_2CO_3
 - (c) PbS** *Sulfides are NOT soluble*
 - $(NH_4)_2SO_4$
 - $Ba(C_2H_3O_2)_2$
- In a ~~metathesis~~ ^{DOUBLE REPLACEMENT} reaction, formation of which of the following does not necessarily lead to a chemical change?
 - $HC_2H_3O_2$
 - $AgCl$
 - CO_2
 - H_2S
 - (c) $NaCl$** *YOU NEED A PRECIPITATE, A GAS, WATER, OR A WEAK ELECTROLYTE*
- Reaction of an acid with a carbonate (such as $CaCO_3$) always results in the formation of
 - O_2
 - $C_{(diamond)}$
 - CH_4
 - O_3
 - (e) CO_2 and H_2O**
- Which of the following is incorrect?
 - all salts containing NH_4^+ are soluble.
 - all salts containing NO_3^- are soluble.
 - (c) all fluorides are soluble.** *see Rule*
 - all sulfates (except those of Ca^{2+} , Sr^{2+} , Ba^{2+} , and Pb^{2+}) are soluble.
 - most hydroxides are insoluble, except those of Ca^{2+} , Sr^{2+} , Ba^{2+} , the alkali metals and NH_4^+ .
- One of the gases shown below is NOT usually formed in a metathesis reaction. Which one?
 - (a) N_2**
 - CO_2
 - SO_2
 - NH_3
 - H_2S

- Write the balanced molecular equation for the reaction of washing soda, Na_2CO_3 and vinegar, $HC_2H_3O_2$.

$$Na_2CO_3 + 2HC_2H_3O_2 \rightarrow H_2O + CO_2 + 2NaC_2H_3O_2$$
- The net ionic equation for the above reaction is:

$$CO_3^{2-} + 2HC_2H_3O_2 \rightarrow H_2O + CO_2 + 2C_2H_3O_2^-$$
- How many moles of H^+ are associated with the acid, H_2SO_3 , during neutralization?
 - 0
 - 1
 - (c) 2**
 - 3*Both H's are available, to NEUTRALIZE!*
- How many moles Al_2O_3 are needed to neutralize 1 mole of HCl ? *HINT: mix $Al_2O_3 + H_2O$*
 - $1/3$
 - $2/3$
 - 2
 - 6
 - 12
 - (f) $1/6$** *$Al(OH)_3$*
$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$$
- Write the net reaction that will occur when solid ammonium carbonate is added to a solution of hydrosulfuric acid.

$$(NH_4)_2CO_3(s) + H_2S \rightarrow H_2O + CO_2 + 2NH_4^+ + S^{2-}$$
- When H_2SO_4 and $Ba(OH)_2$ are reacted in a ^{DOUBLE REPLACEMENT} ~~metathesis~~ reaction, one of the products of the reaction is...
 - H_2
 - (b) H_2O**
 - BaS
 - BaH_2
 - SO_2 *$BaSO_4$ is the other.*
- In the metathesis reaction between the weak acid, $HC_2H_3O_2$ and strong base, $NaOH$, which ion(s) are spectator ions?
 - Na^+ , $C_2H_3O_2^-$
 - Na^+ , OH^-
 - OH^- only
 - H^+ , $C_2H_3O_2^-$
 - (c) Na^+ only**
$$100\% \quad HC_2H_3O_2 + Na^+ + OH^- \rightarrow H_2O + Na^+ + C_2H_3O_2^-$$

13. Which of the following is a base?
 a) KOH
 b) C_2H_5OH *alcohol*
 c) Br^- *nope*
 d) CH_3OH *alcohol*
 e) CO_2 *acid anhydride*

14. Which of the following is a strong acid?
 a) H_2CO_3 *weak*
 b) HF *weak*
 c) H_3PO_4 *weak*
 d) $HClO_3$ *oops!*
 e) HNO_3 *both are on our strong acid list*

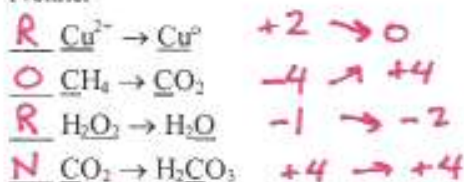
15. Which of the following is an acid in aqueous solutions?
 a) H_2CO_3
 b) Al_2O_3
 c) CH_4 *neutral*
 d) H_2O *neutral*
 e) BaO *basic anhydride*

16. SO_2 turns into which acid in solution?
 a) HNO_3
 b) H_2SO_3
 c) H_2SO_4
 d) H_2S
 e) HNO_2
 $SO_2 + H_2O \rightarrow H_2SO_3$

17. What is the oxidation number of C in CO_3^{2-} ?
 a) +6
 b) +4
 c) +2
 d) +1 *$x + 3(-2) = -2$*
 e) -1 *$x = +4$*

18. What is the oxidation number of Br in $KBrO_4$?
 a) +1 b) -1 c) +5 +7 e) +8
 $1 + x + 4(-2) = 0 \quad x = +7$

19. For each change below, label the change of the underlined element as Oxidation, Reduction, or Neither



THIS IS ACID-BASE

20. How many milliliters of 0.123 M NaOH solution contain 25.0 g of NaOH (molar mass = 40.00 g/mol)?
 a) 5.08 mL
 b) 50.8 mL
 c) 508 mL
 d) 625 mL
 e) 5080 mL

See pages 4 & 5

21. If you need 1.00 L of 0.125 M H_2SO_4 , how would you prepare this solution?
 a) Add 950. mL of water to 50.0 mL of 3.00 M H_2SO_4 .
 b) Add 500. mL of water to 500. mL of 0.500 M H_2SO_4 .
 c) Add 750 mL of water to 250 mL of 0.375 M H_2SO_4 .
 d) Dilute 36.0 mL of 1.25 M H_2SO_4 to a volume of 1.00 L.
 e) Dilute 20.8 mL of 6.00 M H_2SO_4 to a volume of 1.00 L.

See pages 4 & 5

22. What is the ion concentration in a 0.12 M solution of $BaCl_2$?
 a) $[Ba^{2+}] = 0.12 \text{ M}$ and $[Cl^-] = 0.12 \text{ M}$.
 b) $[Ba^{2+}] = 0.12 \text{ M}$ and $[Cl^-] = 0.060 \text{ M}$.
 c) $[Ba^{2+}] = 0.12 \text{ M}$ and $[Cl^-] = 0.24 \text{ M}$.
 d) $[Ba^{2+}] = 0.060 \text{ M}$ and $[Cl^-] = 0.060 \text{ M}$.
 e) $[Ba^+] = 0.12 \text{ M}$ and $[Cl^-] = 0.12 \text{ M}$.

23. What is the molarity of the solution that results when 60.0 g NaOH is added to enough water to make 500. mL solution?

- a) 1.33 M
 b) 12.0 M
 c) 3.00 M
 d) 8.0 M
 e) 1.50 M

See pages 4 & 5

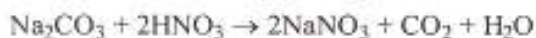
24. What is the molarity of the solution that results when 45.0 g HCl is dissolved in enough water to make 250. mL solution?

- a) 4.94 M d) 1.80 M
b) 4.50 M e) 1.46 M
c) 3.24 M

25. What is the concentration of Cl⁻ ion in 0.60 M AlCl₃ solution?

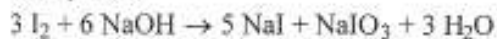
- a) 1.8 M d) 0.30 M
b) 0.60 M e) 0.10 M
c) 0.20 M

26. How many grams of Na₂CO₃ (molar mass = 106.0 g/mol) are required for complete reaction with 25.0 mL of 0.155 M HNO₃?



- a) 0.122 g d) 20.5 g
b) 0.205 g e) 205 g
c) 0.410 g

27. What volume of 0.150 M NaOH is needed to react completely with 3.45 g iodine according to the equation:



- a) 181 mL d) 2.04 mL
b) 45.3 mL e) 1.02 mL
c) 4.08 mL

28. What is the concentration of an NaOH solution if it takes 16.25 mL of a 0.100 M HCl solution to titrate 25.00 mL of the NaOH solution?

- a) 0.0165 M d) 0.100 M
b) 0.151 M e) 0.413 M
c) 0.0650 M

29. A 4.00 M solution of H₃PO₄ will contain ___g of H₃PO₄ in 0.250 L of solution.

- a) 196 g d) 24.0 g
b) 98.0 g e) 12.0 g
c) 49.0 g

*See answer pages
4 & 5
for worked out
answers.*

(20) G: 25.0 g NaOH

D: ? mL

$$25.0 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.0 \text{ g NaOH}} \times \frac{1 \text{ L NaOH}}{0.123 \text{ mol NaOH}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 5081.3 \approx \boxed{5080 \text{ mL}}$$

21) $M_1 V_1 = M_2 V_2$

$$(.125 \text{ M}) \left(\frac{1000 \text{ mL}}{1 \text{ L}} \right) = \underbrace{(6.00 \text{ M}) (20.8 \text{ mL})}_{\text{"e"}}$$

TEST EACH ANSWER
works!



$$\begin{aligned} [\text{Ba}^{2+}] &= [\text{BaCl}_2] = \boxed{.12 \text{ M}} \\ [\text{Cl}^-] &= 2 \times [\text{BaCl}_2] = \boxed{.24 \text{ M}} \end{aligned}$$

23) $M = \frac{\text{moles NaOH}}{\text{Liters solution}} = \frac{(60.0 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.0 \text{ g}})}{.500 \text{ L}} = \boxed{3.00 \text{ M}}$

24) $M = \frac{\text{moles HCl}}{\text{Liters soln}} = \frac{(45.0 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}})}{.250 \text{ L}} = 4.9369 \text{ M} \approx \boxed{4.94 \text{ M}}$



$$[\text{Cl}^-] = 3 \times [\text{AlCl}_3] = 3 \times .60 \text{ M} = \boxed{1.8 \text{ M}}$$

26) G: 25.0 mL HNO_3 solution

D: ? g Na_2CO_3

$$25.0 \text{ mL HNO}_3 \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.155 \text{ mol HNO}_3}{1 \text{ L HNO}_3} \times \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HNO}_3} \times \frac{106.0 \text{ g Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} = \boxed{.205 \text{ g}}$$

27) G: 3.45 g I₂
 D: ? mL NaOH

I₂
126.9

(MM) ♥

$$3.45 \text{ g I}_2 \times \frac{1 \text{ mol I}_2}{253.8 \text{ g I}_2} \times \frac{6 \text{ mol NaOH}}{3 \text{ mol I}_2} \times \frac{1 \text{ L NaOH}}{0.150 \text{ mol NaOH}} \times \frac{1000 \text{ mL}}{1 \text{ L NaOH}} = 181.245 \text{ mL} \approx \boxed{181 \text{ mL}}$$

28) $V_{\text{H}^+} \cdot M_{\text{H}^+} = V_{\text{OH}^-} \cdot M_{\text{OH}^-}$ (TITRATION)

$$(16.25 \text{ mL})(.100 \text{ M}) = (25.00 \text{ mL})x$$

$$x = \frac{(16.25)(.100)}{(25.00)} = \boxed{.0650 \text{ M}}$$

-OR- DO IT AS A STOICHIOMETRY PROB.



$$M = \frac{\text{moles NaOH}}{\text{Liters NaOH}} = \frac{x_{\text{NaOH}}}{25.00 \text{ mL NaOH} \cdot 0.025 \text{ L}} = \frac{1.625 \times 10^{-3} \text{ mol}}{0.025 \text{ L}} = \boxed{.0650 \text{ M}}$$

G: 16.25 mL HCl

D: ? mol NaOH

(M)

$$16.25 \text{ mL HCl} \times \frac{.100 \text{ mol HCl}}{1000 \text{ mL}} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HCl}} = 1.625 \times 10^{-3} \text{ mol NaOH}$$

29) G: .250 L H₃PO₄ soln
 D: ? g H₃PO₄

H₃ = 3.03
 P = 30.97
 O₄ = 64.00
 98.00

$$.250 \text{ L} \times \frac{.4.00 \text{ mol H}_3\text{PO}_4}{1.00 \text{ L}} \times \frac{98.00 \text{ g H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} = \boxed{98.0 \text{ g H}_3\text{PO}_4}$$